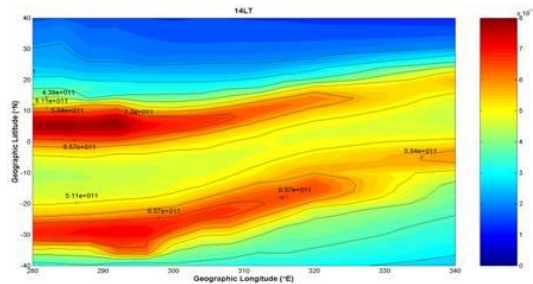


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14. ABSTRACT This AFOSR grant dealt with three, fundamentally-important questions related to understanding the daytime, equatorial ExB drift velocities associated with the 4-cell, non-migrating tidal structures. The three important questions that were addressed 1.) How sharp are the longitude gradients in daytime, vertical ExB drift velocities that define the boundaries of each of the 4 cells, 2.) Is the 4-cell pattern in ExB drifts observed on a day-to-day basis? and 3.) Can a theoretical model such as the Whole Atmosphere Model (WAM) produce the observed sharp longitudinal gradients in ExB drift velocities? It was found that the longitude gradients in ExB drift velocities were extremely sharp and varied between 1 m/sec/degree and -4 m/sec/degree longitude and these gradients were observed on a day-to-day basis. The WAM model was not able to reproduce such large gradients, but did reproduce the 4-cell structure in daytime, vertical ExB drift velocities.					
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AFOSR Final Report

This AFOSR grant dealt with three, fundamentally-important questions related to understanding the daytime, equatorial ExB drift velocities associated with the 4-cell, non-migrating tidal structures. The three important questions that were addressed 1.) How sharp are the longitude gradients in daytime, vertical ExB drift velocities that define the boundaries of each of the 4 cells, 2.) Is the 4-cell pattern in ExB drifts observed on a day-to-day basis? and 3.) Can a theoretical model such as the Whole Atmosphere Model (WAM) produce the observed sharp longitudinal gradients in ExB drift velocities? To carry out the investigation outlined in this AFOSR grant, we obtained observations from the Ion Velocity Meter (IVM) on board the Communication/Navigation Outage Forecast System (C/NOFS) satellite. Being able to measure the daytime, vertical ExB drift velocities as a function of local time, longitude and season were the required observations to answer these three questions. IVM observations were examined between 10 and 13 LT and below 500 km altitude for all of the months in 2009. There were approximately 10 days per month that met these constraints. In answering the first question, we found that the longitude gradients in daytime, vertical ExB drift velocities were **extremely sharp, ranging in value from +1 m/sec/degree longitude to -4 m/sec/degree longitude**. It was also found that these sharp longitude gradients were observed on a day-to-day basis. These results have been published in 2010 in Radio Science. The title of the paper is “Communications/Navigation Outage Forecasting System observational support for the equatorial ExB drift velocities associated with the four-cell tidal structures” by Eduardo A. Araujo-Pradere, David N. Anderson, Mariangel Fedrizzi and Russell Stoneback (Radio Science, vol. 46, Article #RS0D09, DOI:10.1029/2010RS004557). The effects of these sharp gradients on calculated electron densities as a function of altitude, latitude, longitude and local time were then theoretically investigated. The theoretical, time-dependent Global Ionosphere Plasmasphere (GIP) ionospheric model was used to carry out the calculations. It was found that the sharp longitude gradients in ExB drift velocity produced very sharp longitude gradients in the latitude locations of the crests of the equatorial anomaly. These features are illustrated in Figure 1. These results have been published in Radio Science, Volume 47, RS0L12 DOI:10.1029/2011RS004930, April 26, 2012. The paper is entitled “Modeling the Daytime, Equatorial Ionospheric Ion Densities Associated with the Observed, 4-cell Longitude Patterns in ExB Drift Velocities” and is authored by Eduardo A. Araujo-Pradere, Tzu-Wei Fang, David N. Anderson, Mariangel Fedrizzi and Russell Stoneback. In addition, the results of this study have been presented at the Second LISN Workshop in Brazil in November, 2011, the 2011 Fall AGU meeting in San Francisco and at the ISEA13 meeting in Paracas, Peru in March, 2012. Finally, preliminary runs of the coupled WAM and GIP models demonstrated that a 4-cell structure could be produced when the diurnal, non-migrating, eastward propagating wave number 4 (DE3) had a significant tidal component in the WAM output. The associated daytime, vertical ExB drift velocities as a function of longitude are pictured in Figure 2. The sharpest longitude gradients in the calculated ExB drift velocities occur between the Peruvian sector and the Atlantic sector but are not as steep as those pictured in the insets of Figure 1. However, the fact that WAM/GIP simulations do produce the 4-cell, non-migrating tidal structures is encouraging. From a modeling standpoint, the important unanswered questions relate to what physical mechanisms realistically account for the observed steep gradients in ExB drift velocities at the boundaries between the 4-cell, non-migrating structures. Are they caused by a superposition of different tidal modes, or a phase change with height of the various waves, or a contribution from both E and F region winds? These fundamental issues are still outstanding and need to be addressed!

Quantifying the Daytime, Equatorial ExB Drift Velocities Associated with the 4-cell, Non-migrating Tidal Structures



- Theoretically-calculated electron densities using the time-dependent Global Ionosphere Plasmasphere model (GIP)
- The Scherliess – Fejer climatological ExB drift velocity model produces symmetric crests in ionization on either side of the magnetic equator known as the Equatorial Anomaly

- Incorporating the sharp longitude gradients in IVM-observed ExB drift velocities (see inserts) produces sharp longitude gradients in the location of the crests
- Between 290° and 300° E. geog. long., the crests move from +/- 15° mag. lat. to the magnetic equator
- No crests exist between 300° and 305°
- Between 305° and 340° the crests move back out to +/- 15° mag. latitude

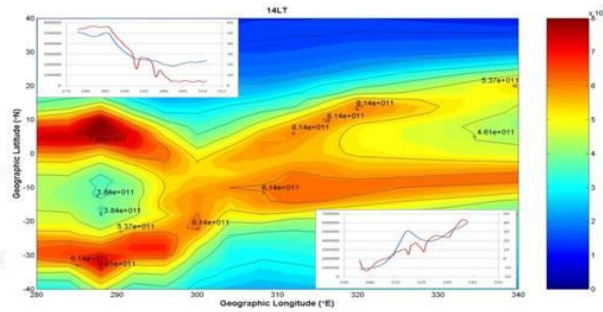


Figure 1. Theoretically-calculated electron densities at 1400 LT and 400 km altitude as a function of geographic latitude and longitude (see text for details).

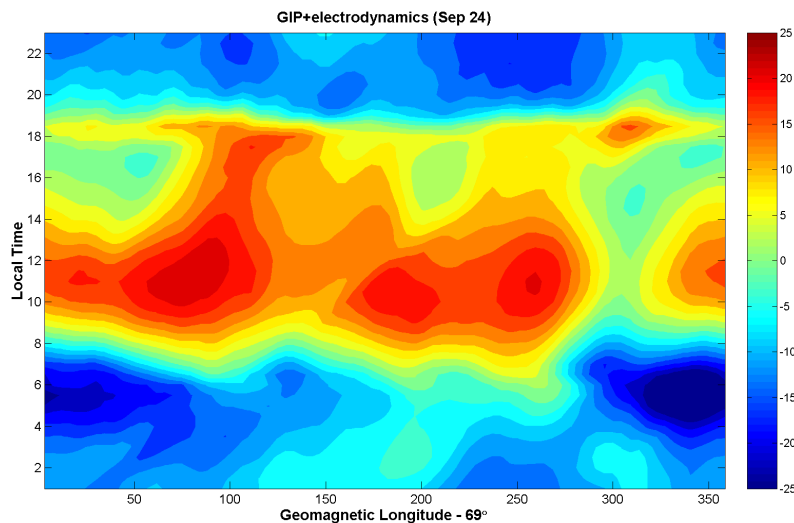


Figure 2. Theoretically-calculated, vertical ExB drift velocities at 400 km as a function of local time and geographic longitude (see text for details).